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Technical Report

The Effect of Gasohol on I/M Programs

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Introduction

The use of gasohol (10% ethanol and 90% gasoline by volume) can significantly reduce FTP mass exhaust emissions of HC and CO. Test projects in Denver and in the EPA Ann Arbor lab (MVEL) reported average reductions of about 10% in FTP HC emissions and 30% in FTP CO emissions[1,2].* Increases in NOx and evaporative HC emissions were also noted. Neither of these programs studied the effect on idle emissions, however.

A later test program was therefore run at MVEL to investigate the effects of gasohol on idle emissions(3). Two catalyst vehicles had decreases in idle emissions of 1.1% CO and 200 ppm HC when they were operated close to the New Jersey I/M standards of 3.0% CO and 300 ppm HC. This showed that there was reason for concern that the use of gasohol may allow vehicles to pass an I/M test which would normally fail the test on gasoline.

I/M staff decided to study the matter further. An appropriate and inexpensive way to test a large number of vehicles was to add gasohol short tests to an already planned test program. The test program chosen was a study in Portland which would be testing about 200 vehicles from Portland and Vancouver[4]. The vehicles were 1976 and 1978 model years, representing an emission technology which would comprise the majority of vehicles tested in most I/M programs in the 1980's.

Summary

The idle emission changes with gasohol varied with the different short tests. Using the first idle readings of the Two-Speed Idle Test, average idle HC emissions increased by 19% while CO emissions decreased by 13% with gasohol. Using the second idle readings, HC increased by 8% and CO decreased by 9%. These results -- the HC increases and the small CO decreases -- conflict with the earlier study which showed large reductions in both idle HC and CO with gasohol. The earlier study only tested two vehicles, however.

Gasohol generally caused a change in failure rate. The change varied depending on the test used, however. For the 207(b) Emission Performance Warranty cutpoints, the failure rate using the first idle portion of the Two-Speed Idle Test increased with gasohol from 39% to 46%. The failure rate using the second idle portion decreased with gasohol, however, from 27% to 23%. The failure rate using the full Two-Speed Idle Test (testing at both idle and 2500 rpm) remained essentially unchanged at 35%.

The change in failure rate was almost entirely due to CO emission changes, not HC. For example, using the second idle portion of the Two-Speed Idle Test, the number of vehicles failing a 2% idle CO cutpoint decreases from 17.5% to 11% with gasohol, whereas the number of vehicles failing a 300 ppm HC cutpoint remains unchanged at 11.5%.

*Numbers in brackets indicate references listed at the end of the report.

Importance of the Results to I/M Programs

The use of gasohol does not appear to be a significant problem for I/M programs. Results indicate that some vehicles will have higher emissions with gasohol and some lower. The fact that failure rate changes in this study varied with the type of test, sometimes increasing and sometimes decreasing, indicates that the I/M failure rate may not noticeably change for a large fleet of vehicles if gasohol usage suddenly increased.

The extent to which gasohol use becomes even a slight problem in I/M programs depends on the degree of its usage in general and the manner of its usage by individual owners. For example, if owners who normally use gasoline use gasohol only in order to try to pass the I/M test, the program effectiveness may decline due to the slight reduction in effective failure rate. EPA expects that this would not be a widespread problem, however, due to the majority of the public either being disinterested in trying to pass the test with just a fuel change or being unaware of the possibility. The fact that many vehicles will have higher emissions with gasohol may also discourage people from trying.

General usage of gasohol does not appear to be increasing and interest in it has declined. The economics of gasohol usage is heavily influenced by federal and state subsidies and other incentives for its production and use. In the absence of subsidies, gasohol is generally not competitive and would be unavailable in most areas. .

Test Results

Each vehicle was tested on the Four-Mode Idle Test with normal unleaded test fuel and with gasohol. This test is the same as the Two-Speed Idle Test with the addition of an idle emissions reading in Drive for vehicles with automatic transmissions. Emissions for the simple Idle Test can be taken from the first idle Neutral reading.

A total of 212 vehicles were tested. Their average short test emissions are shown in Table 1. On the average, all HC emissions increased with gasohol and all CO emissions decreased. Table 2 presents the results for only the vehicles which failed the Portland I/M test at a State lane. Directional changes and some of the percent differences were similar for the groups in both tables.

Table 1

Average Short Test Emissions
For All Vehicles (N=212)

	First Idle		2500 rpm		Second Idle	
	HC	CO	HC	CO	HC	CO
Gasoline	206	1.12	76	0.27	142	0.77
Gasohol	246	0.97	104	0.21	153	0.56
% Difference	+19%	-13%	+37%	-22%	+8%	-9%

Table 2

Average Short Test Emissions For
Vehicles Failing Portland I/M Test (N=71)

	First Idle		2500 rpm		Second Idle	
	HC	CO	HC	CO	HC	CO
Gasoline	357	2.20	105	0.52	295	2.10
Gasohol	387	1.91	151	0.32	288	1.55
% Difference	+8%	-13%	+44%	-38%	-2%	-26%

A major concern for I/M programs is the effect on idle test failure rate that the use of gasohol has. Because the failure rate depends on the cutpoints used, which will vary from state to state, idle emissions of HC and CO were separated into several categories. These categories reflect some of the cutpoint strategies different states may use. Table 3 shows the number of vehicles within five categories for idle HC and CO. Idle emissions were taken from the second idle portion of the Four-Mode Idle test. The way to use this table is to count up the number of vehicles above a certain cutpoint for gasoline and gasohol and compare the difference. For example, the number of vehicles above 2% idle CO is 16+9+7+3 = 35 vehicles with gasoline and 11+4+5+2 = 22 vehicles with gasohol. Since Table 3 uses the matched sample of 200 vehicles in the study (100 Portland vehicles matching 100 Vancouver vehicles by make, model year, etc.) the idle CO failure rates for this example are 17.5% and 11% respectively for gasoline and gasohol, showing a reduction of 6.5 percentage points in idle CO failure rate with the use of gasohol. There is essentially no effect on the idle HC failure rate with the use of gasohol.

Table 3

Numbers of Vehicles Within Certain Categories
of Idle Emissions for Gasohol
Versus Gasoline (N=200)

	Idle CO				
	1-2%	2-3%	3-4%	4-5%	5%
Gasoline	15	16	9	7	3
Gasohol	17	11	4	5	2

	Idle HC (ppm)				
	225-300	300-400	400-500	500-600	600+
Gasoline	8	8	6	4	5
Gasohol	6	8	5	2	7

For a second example, the specific cutpoints called for in the 207(b) Emission Performance Warranty were used. These cutpoints are very similar to the Portland I/M cutpoints for most of the vehicles in the study. The simple Idle test was evaluated in two ways: using the first idle readings from the Two-Speed Idle Test and using the second idle readings. This was done because some states will specify a preconditioning before the idle measurements similar to the 2500 rpm engine operation prior to the second idle readings in the Two-Speed Idle Test. The failure rates for the Idle Tests and the Two-Speed Idle Test are shown in Table 4.

The use of only the first idle readings gives the highest failure rates and, surprisingly, more vehicles fail using gasohol than gasoline. Nine vehicles (4.3%) fail on gasohol and pass on gasoline, whereas 24 vehicles (11.4%) fail on gasoline and pass on gasohol. These trends are reversed using the second idle emissions. More total vehicles failed with gasoline than gasohol and 14 vehicles (6.6%) failed with gasoline and passed with gasohol versus only 6 vehicles (2.8%) failed with gasohol and passed with gasoline. The second idle readings give more consistent results also, i.e. fewer vehicles fail on only one fuel than in the first idle. The Two-Speed Idle Test shows nearly the same fail rates with both gasoline and gasohol and also compares well with the Portland I/M fail rate.

Table 4

Failure Rates With Gasoline and Gasohol
Using 207(b) Cutpoints

Test	Gasoline Failure Rate	Gasohol Failure Rate	Cutpoints HC	CO
First Idle	39%	46%	220 ppm	1.2%
Second Idle	27%	23%	220ppm	1.2%
Two-Speed Idle	35%	36%	200 ppm	1.0% (at both speeds)
Portland I/M Program	33%	-		

REFERENCES

1. "Exhaust Emissions and Fuel Economy From Automobiles Using Alcohol/Gasoline Blends Under High Altitude Conditions", EPA report 79-1, October, 1978.

2. "Gasohol Test Program", EPA-AA-TAEB-79-4B, February 1980.

3. "Effects of Gasohol on Idle HC and CO Emissions", EPA-AA-IMS/ST-80-4, March 1980.

4. "Vancouver Versus Portland Vehicle Emissions", Test Group Technical Direction No. 9 to EPA Contract No. 68-03-2829.